WHITEWASHING CRENSHAW AND CANTALOUP MELONS TO REDUCE SOLAR INJURY

Marketing Research Report No. 1045

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

ACKNOWLEDGMENTS

The following California companies contributed materials, or services, or both to this research:

Wilbur-Ellis Co., Fresno
W. J. Deal Co., Mendota
Pacific Farm Co., Firebaugh

Their unstinting cooperation is greatly appreciated.

I am also grateful to R. T. Hinsch, who developed the information on the economic aspects of whitewashing and to C. M. Harris, R. E. Rij, and F. Matoba, who assisted in various aspects of this work.

CONTENTS

Issued December 1975

WHITEWASHING CRENSHAW AND CANTALOUP MELONS TO REDUCE SOLAR INJURY

BY WERNER J. LIPTON, *plant physiologist, Market Quality and Transportation Research Laboratory, Western Region, Agricultural Research Service, Fresno, Calif. 93727*

SUMMARY

When an inert, nontoxic whitewash was applied to maturing Crenshaw and cantaloup melons, surface and flesh temperatures of the melons were reduced by about 7° and 10° F, respectively, compared with unprotected melons.

In Crenshaws, whitewashing reduced the incidence of solar injury severe enough to render the melons unmarketable to less than half that in melons that had been hand-covered with vines, the usual commercial practice. In cantaloups, whitewashing virtually eliminated severe solar injury.

Whitewashing had no adverse effect on the soluble solids content of the melons or on any other criterion of quality.

The whitewash can be removed from Crenshaws by wet-sponging and from cantaloups by washer-brushers that contact the entire melon.

Whitewashing would afford a potential increase in returns from these melons of at least $100 per acre, would reduce stoop labor, and would give the consumer a better product, possibly at a lower price.

INTRODUCTION

Crenshaw melons are highly prized for their delicate flavor and buttery texture. They also are high priced, partly because they require very gentle handling and partly because many Crenshaws are unmarketable because of excessive "sunburn." In the San Joaquin Valley of California, a major area of melon production in the United States, between 10 and 30 percent of the crop is discarded at the shipping point because of sunburn. Assuming a minimum loss, these wasted melons had a potential FOB value of about $150,000 in 1972, based on midsummer plantings of about 1,000 acres (*1*).[1] These losses occur in spite of efforts to prevent sunburn by repeatedly hand-covering the melons with vines, straw, or other materials.

The precautions are only partly successful because wind moves the cover, leaves of vines die and expose the melons, and not all melons receive adequate cover initially. These problems suggested that whitewashing, which had been successfully used to protect walnuts from sunburn (*9*), might also serve to protect Crenshaw melons.

Cantaloup losses due to sunburn have been estimated at about 10 percent of the midsummer crop in the San Joaquin Valley.[2, 3] Because the FOB value of midsummer melons is about $30 million, sunburn causes a loss of about $3 million. These losses do not include those sustained in the desert growing areas of California and Arizona, where the generally clear skies are at

[1] Italic numbers in parentheses refer to Literature Cited, p. 15.

[2] ANONYMOUS. CAUSES OF CANTALOUP CULLS. Calif. Univ. Agr. Ext. Serv., Perishables Handling. September 1962. [Mimeographed.]

[3] Kasmire, R. F., University of California, Davis, personal commun., 1973.

least as conducive to sunburn as weather is in the San Joaquin Valley.

Protection of cantaloups, which are less susceptible to sunburn than Crenshaws, depends entirely on an adequate cover of vines. However, during repeated harvests the vines are damaged, and many melons become exposed to radiation from sun and sky. Consequently, whitewashing also may be useful to protect cantaloups from sunburn.

Although some of the research reported here has been previously published (*6*, *7*), the combination of these earlier results and more recent findings from larger scale tests should give growers and shippers an objective basis for evaluating the merits of whitewashing melons on a commercial scale.

METHODS AND MATERIALS

General

Terminology

The popular terms "sunburn" or "sunscald" imply that the visible injury that results from excessive exposure of horticultural crops to solar radiation is caused primarily by excessive heating of the tissue. However, sunburn may be caused by the combined effects of heat and ultraviolet radiation (*5*, *7*). Because the effects of solar infrared (heat) and ultraviolet radiation are not distinguished in this work, the term "solar injury" (SI), employed by Ryall and Lipton (*8*), will be used.

Whitewashing

Experimental conditions applicable to whitewashing Crenshaws and cantaloups are detailed in table 1.

The melons used in this study were grown commercially in western Fresno County, Calif., (about latitude 36° 46′ N), during the summers of 1971 through 1973, although tests had been conducted on a smaller scale in prior years. All fields were nearly level and were furrow irrigated.

The whitewash was a proprietary material, Snow,[4] that consisted primarily of aluminum silicate, a mined, nonmetallic product with a reflectance of about 90 percent at 546.1 nanometers. Whiteners may be added to increase reflectance. This and similar materials are being widely used in the arid West to minimize SI on tomatoes grown for processing. We tested only one whitewash, because the tests were intended to determine the potential usefulness of the process, not to compare whitewash materials.

In 1971 and 1972, Snow was used. However, because this material could not be readily removed from harvested melons, in 1973 we tested formulations that were intended to adhere less firmly. In one of these formulations, the content of the clay that binds the whitewash to the sprayed surface was reduced; in the other, a thickener that enhanced whiteness was added. The whitewash was applied with a commercial sprayer (fig. 1) used for whitewashing tomatoes.

Temperature Measurement

Flesh temperatures were measured with a precision of ±0.5° F at 1 to 2 and 15 to 30 mm below the top surface of Crenshaws and at the two shallower depths in cantaloups by means of iron-constanan thermocouples connected to a po-

PN–4219
FIGURE 1.—Sprayer applying whitewash to melons.

[4] Wilbur-Ellis Co., Fresno.

TABLE 1.—*Experimental conditions for whitewashing Crenshaws and cantaloups*

Date of whitewashing	Whitewash			Surfactant		Rows per treatment	Length of each row	Initial condition of vines	Dates of harvest	Maximum air temperatures during tests[1]	
	Formulation	*Lb/gal*	*Gal/acre*	*Name*	*Pints/100 gal*	*Number*	*feet*			Range *°F*	Mean *°F*
Crenshaws											
1971:											
Aug. 13	Commercial[2]	1	150	[5]S22-W	2	4	100	Good	Aug. 17, 20, 24, 27	95–102	99
1972:											
Aug. 8	----do-----	¾, 1	150	[6]B1956	2	4	100	Good	Aug. 11, 14, 18	79– 99	91
1973:											
Aug. 7	Commercial minimal binder[2, 3]	¾	100	B1956	1	3	300	Some good to fair; mostly good to excellent	Aug. 10, 13, 16	90–101	96
	Commercial plus thickener[2, 4]	¾	100	B1956	1	3	300				
Cantaloups											
1971:											
July 22	Commercial[2]	1	150	[5]S22-W	6	4	60	Good	July 26, 29	95–102	99
Aug. 13	----do-----	1	150	[6]B1956	2	2	60	Good	Aug. 17, 20, 24, 27	91–100	96
1972:											
July 18	----do-----	¾, 1	100	B1956	3	2	75	Good to fair	July 21, 24	82– 91	87
Aug. 8	----do-----	¾, 1	100	B1956	3	2	75	Excellent	Aug. 11, 14, 18	79– 99	91
1973:											
Aug. 7	Commercial minimal binder[2, 3]	¾	100	B1956	1	2	150	Good	Aug. 10, 13	90– 99	95
	Commercial plus thickener[2, 4]	¾	100	B1956	1	2	150				

[1] Mean for Los Banos Detention Reservoir and University of California West Side Field Station near Five Points.
[2] Snow, a proprietary product of the Wilbur-Ellis Co.
[3] Less than 10 percent.
[4] Based on Cellosize, a proprietary product of the Union Carbide Co., ½ lb/100 gal.
[5] Wilbur-Ellis Co.
[6] A Triton formulation, Rohm and Haas Co.

tentiometer. The wire diameter was 0.4 mm for the thermocouples inserted 1 to 2 mm below the surface and 0.7 mm for the others.

Surface temperatures were measured to ±2° F with an infrared thermometer.[5] The electronics console was shaded with white paper or aluminum foil (*4*). An emissivity of 1 was assumed for all surfaces.

Air temperature was measured at a height equal to the top (Crenshaws) or the middle (cantaloups) of the melons and about 6 inches to their side. The thermocouples (w diameter) were shaded b the sun; temperature read thermocouple by about 3.5

Maximum are the mea voir (*11*) West Side temperatur mental plc points and able.

[5] Model IT-3, Barnes Engineering Co., Stamford, Conn.

Soluble Solids Content

The soluble solids content (SSC) of the flesh of the melons was measured separately on the top and bottom of the fruits at their equator, either on the day of harvest (initial values) or immediately after storage. Data for the halves were analyzed separately because potential differences in SSC due to whitewashing presumably would have been greatest between the top halves of whitewashed and normal melons. Plugs of flesh were cut with a cork borer 7 mm (test of July 1971 only) or 10 mm in diameter, and the juice was expressed with a garlic press after removal of the inedible rind. Readings (±0.1 percent soluble solids) were made at room temperature with a temperature-compensated hand-refractometer.[6]

Arrangement of Plots and Analysis of Data

The treatments were in adjacent rows, except where rows needed for vehicles intervened. In such cases, the number of rows needed for one replication was between such unusable rows. The number of rows (replications) per treatment and their length are given in table 1.

Appropriate data were tested by analysis of variance, and the means were compared with Duncans' Multiple Range Test. Because several harvests were taken from the same row in all tests and the concentration of whitewash was superimposed on spray treatments in some tests, analysis for split plots was used. Where necessary, the data were transformed (*10*) for analysis and then retransformed for presentation.

Crenshaws

Handling of Vines

Protection of Crenshaw melons in the control rows from SI was attempted by repeatedly draping vines over the fruits or by covering them with weeds. This normal, commercial practice was carried out by the regular field crew. In rows to be whitewashed, the vines remained undisturbed, and any cover that had obviously been placed on a melon was removed before whitewashing started. By the time of treatment, the fields had been harvested three or four times, which had disturbed the vines to some extent. The general condition of the vines at the time of whitewashing is given in table 1. Melons with severe or extreme SI were not sampled. Slight or moderate injuries were outlined, and only injury sustained after start of the test was evaluated.

[6] American Optical Co.

Harvest Procedures

All Crenshaws that reached commercial ripeness (that is, the skin was at least streaked with yellow) in each plot during the tests were harvested.

The melons were cut from the vine, leaving about 1 inch of pedicel attached to the melon, a procedure generally believed to minimize the hazard of stem-end decay during storage.

After harvest, the melons were transported under refrigeration to our laboratory in Fresno where they were evaluated before and after storage.

Removal of Whitewash

The whitewash was removed from the melons by sponging them in a tub of water prior to quality evaluation or storage at the laboratory. In 1973, a potential commercial procedure was simulated during one of the harvests by having the melons wet-sponged by members of the packing crew on a mobile unit (fig. 2).

PN-4220

FIGURE 2.—Mobile unit for packing Crenshaw melons in in field.

Storage Conditions

The influence of whitewashing on the market quality of Crenshaws, other than SI, was evaluated in 1971 and 1972 after a simulated marketing period of 10 days at 50° F plus 3 days at 68°. Each treatment consisted of at least 20 melons.

Evaluation of Visual Quality

SI was rated on all melons, either immediately after harvest or after storage, on the following scale:

1, none.
3, slight; patch of green or gray green remaining amid yellow surface, no brown or white discoloration.
5, moderate; brown or white patches with a major dimension of about 1¼ inches (diameter of a 50-cent piece).
7, severe; color as in rating of 5, but larger area; melon not normally marketable.
9, extreme; color as in rating of 5, but major portion of upper surface affected; melon never marketable.

Typical examples of SI ratings are shown in figure 3.

Decay was recorded according to location and noted as being present or absent, because any amount of decay normally makes a Crenshaw unmarketable.

Cantaloups

Handling of Vines and Harvest Procedures

The vines were not deliberately disturbed, but the amount of cover they provided for the melons depended on vine condition (table 1). Four or five commercial harvests prior to our tests had resulted in some vine damage, and a substantial proportion of the melons was exposed to direct solar radiation part of each day regardless of vine condition, but we made no count of exposed melons.

All cantaloups in a plot that reached the full-slip stage during a test were harvested; the lowest degree of ripeness was "hard ripe," but most melons had reached "eastern choice" or "western choice" (*8*).

Removal of Whitewash and Storage Conditions

Removal of whitewash was attempted by passing the melons through washer-brushers at commercial packing sheds.

Cantaloups were stored 8 days at 41° F plus 2 or 3 days at 68°. The crates were covered with well-ventilated plastic bags to prevent excessive water loss from the fruits and modification of the atmosphere. Each of the treatments consisted of at least 20 melons in each test.

Evaluation of Visual Quality

Each melon was rated for SI and ripeness at harvest, and those stored were also rated for vein tract browning and decay when removed from storage.

SI of cantaloups was rated on the following scale:

1, none.
3, slight; small patch of green remaining amid normal tan surface.
5, moderate or just noticeable bronzing along vein tract; green area covering one-fourth or more of top half of melon or noticeable bronzing and glossiness on one or more vein tracts; melon usually marketable.
7, severe; as 5, but green and bronzing present, or substantial bronzing and bleaching of one or more vein tracts; melon not usually marketable.
9, extreme; bleaching of two or more vein tracts and adjacent area or more severe injury; melon never marketable.

Figure 4 illustrates SI ratings of 5 and 7.

Vein tract browning was rated on the following scale:

1, none.
3, slight; just noticeable browning of one or more vein tracts.
5, moderate; definite browning on one or two vein tracts; discoloration objectionable, but melon usually marketable.
7, severe; one or two vein tracts entirely brown or three or more with definite browning; melon not usually marketable.

9, extreme; three or more vein tracts and some adjacent area brown; melon never marketable.

Figure 5 illustrates degrees of vein tract browning corresponding to ratings of 5 through 9.

Decay is noted as being present or absent because a melon with any amount of decay normally is unmarketable.

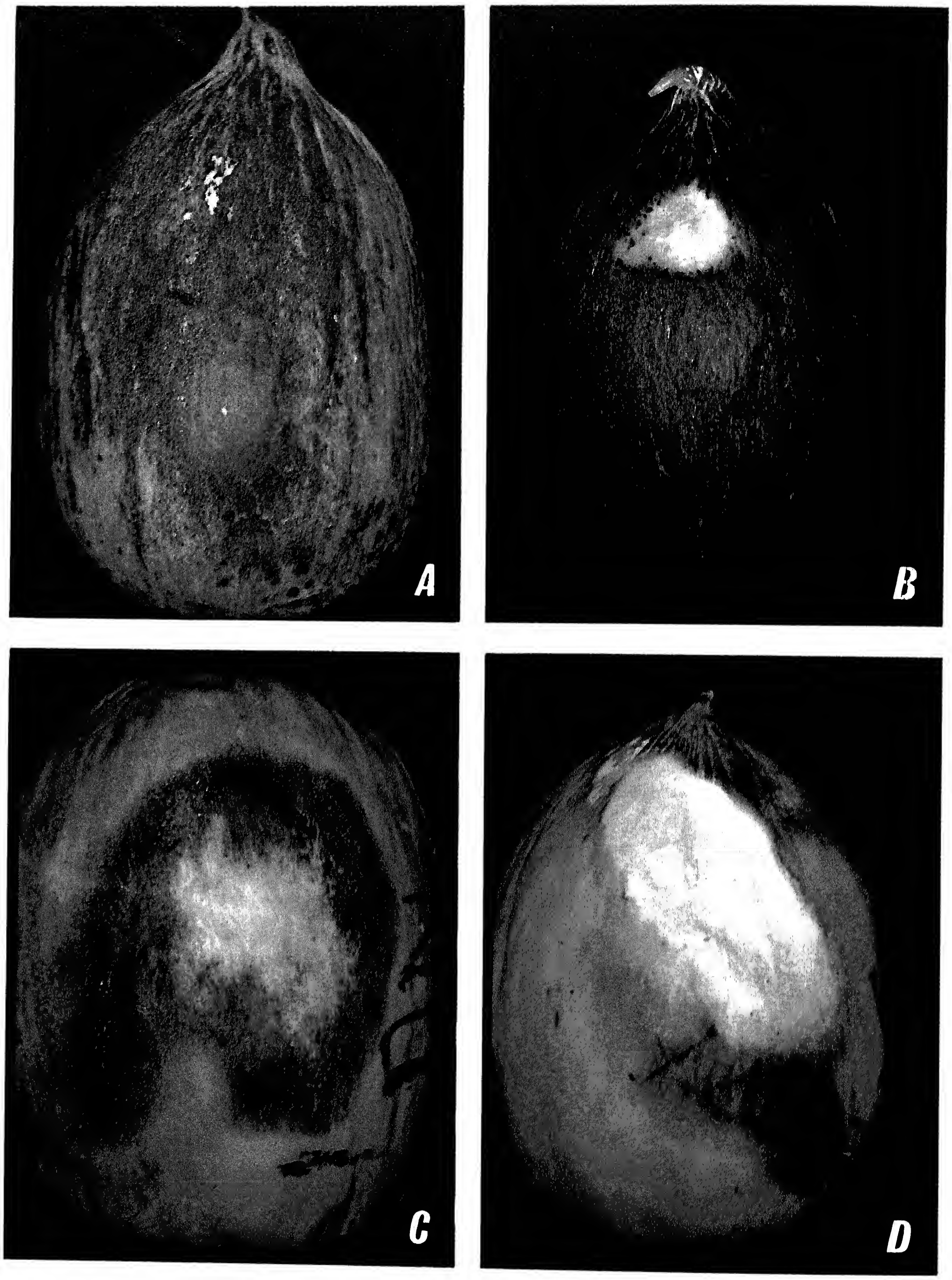


FIGURE 3.—Solar injury ratings of Crenshaw melons: *A*, 3=slight; *B*, 5=moderate; *C*, 7=severe; *D*, 9=extreme.

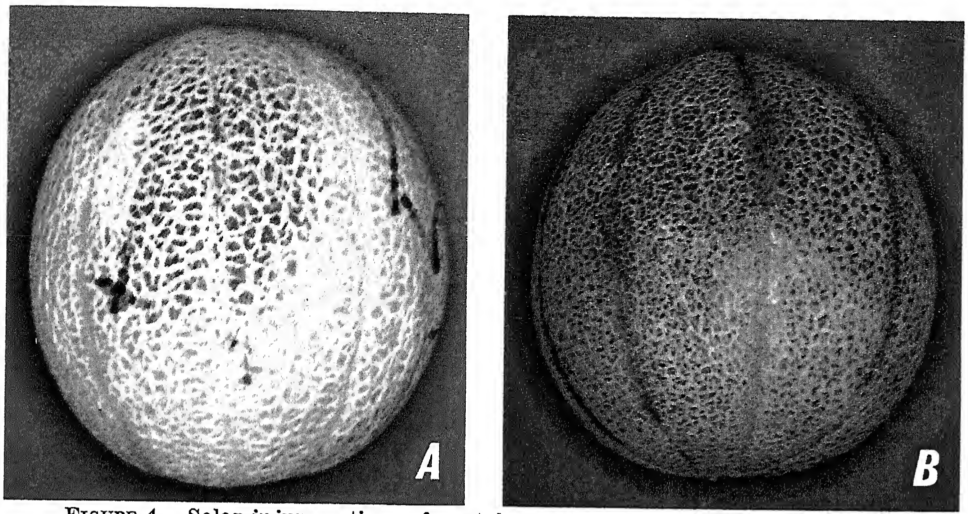
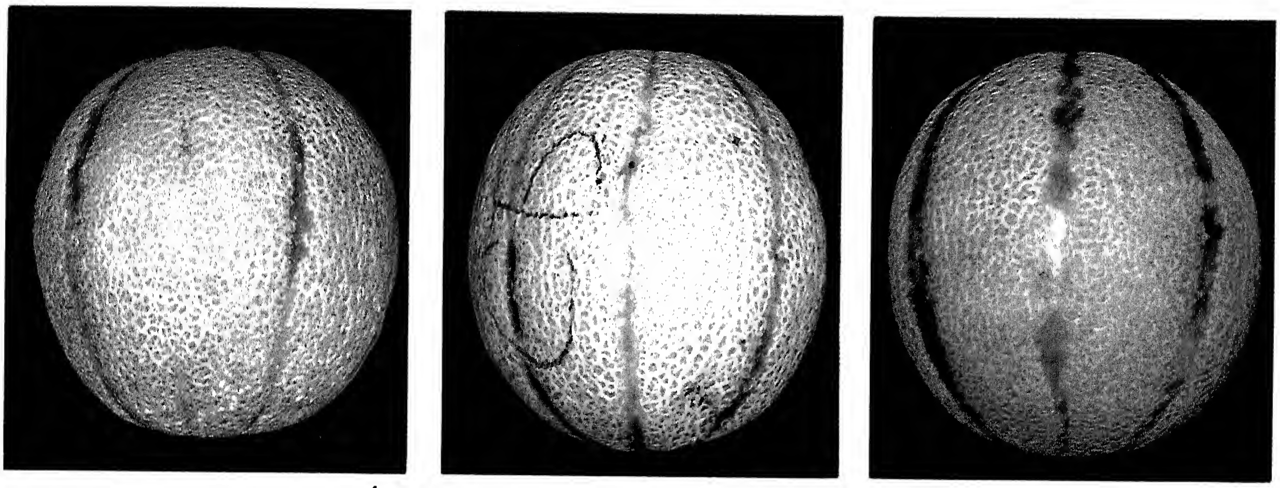


FIGURE 4.—Solar injury ratings of cantaloups: *A*, 5=moderate; *B*, 7=severe.



A *B* *C*

FIGURE 5.—Vein tract browning of cantaloups: *A*, 5=moderate; *B*, 7=severe; *C*, 9=extreme.

RESULTS

Crenshaws

Temperatures

In a whitewashed melon, the maximum pulp temperature 1 to 2 mm under the surface was about 7° F lower (fig. 6) and the surface temperature was about 13° lower (fig. 7) than the corresponding temperatures in an unprotected melon when both were exposed to the sun. However, both exposed melons were substantially warmer than a melon shaded by vines. Similar differences existed among temperatures measured 15 and 30 mm below the surface. Surface and pulp temperatures measured periodically during these tests were similar to those given in figures 6 and 7.

The tempering influence of the whitewash is also evident from a comparison of pulp and air temperatures. The temperature of the whitewashed melon at 1 to 2 mm depth exceeded that of the air (95° F) by 13°, but the unprotected fruit exceeded it by 22°. The temperature of the melon protected by vines remained below that of the air during the entire day. Thus, whitewashing provides substantial protection from excessive heating, but less than a good cover of vines.

The surface and the underlying flesh of a normal exposed melon warmed to about the same temperature (122° F), but the surface of the whitewashed melon was 2° to 3° cooler than its flesh when measured from about noon on (compare figs. 6 and 7). Thus, even though the white surface reflected much heat, the flesh gradually accumulated heat during the day, although less than in a normal melon. A similar situation exists in tomatoes (*5*).

Solar Injury

Whitewashing is intended to prevent SI, particularly injury severe enough to render affected melons unmarketable. In 2 of 3 years, whitewashing accomplished this purpose better than the laborious draping of vines over exposed melons, and in the third year (1972) the trend was in the same direction (table 2).

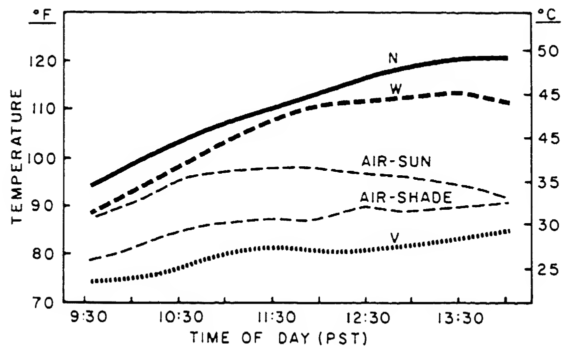


FIGURE 6.—Pulp temperatures of Crenshaw melons 1 to 2 mm below top surface and air temperatures in sun or in shade of vines (July 23, 1970). N = normal melon exposed to sun; W = whitewashed melons exposed to sun; V = normal melon in shade of vines. (From Lipton and Matoba, *1971.*)

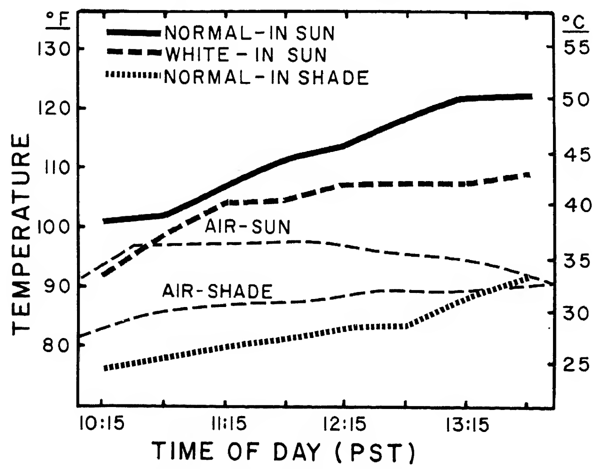


FIGURE 7.—Surface temperature at top of normal and whitewashed Crenshaw melons and air temperatures in sun or in shade of vines (July 23, 1970). (From Lipton and Matoba, *1971.*)

TABLE 2.—*Incidence of solar injury of Crenshaw melons as influenced by whitewashing*

Year of test	Injury rating [1]	Melons with solar injury under indicated conditions [2]: Shaded by vines	Melons with solar injury under indicated conditions [2]: Whitewashed
		Percent	*Percent*
1971	Slight or moderate	20a	15a
	Severe or extreme	22b	3a
	Total	42b	18a
1972 [3]	Slight or moderate	18a	21a
	Severe or extreme	12a	5a
	Total	30a	26a
1973 [4]	Slight or moderate	15a	8a
	Severe or extreme	12b	2a
	Total	27b	10a

[1] Rating scale equivalent: Slight = 3, moderate = 5, severe = 7, extreme = 9.

[2] Percentages on a line followed by different letters differ at the 95-percent probability level.

[3] Data are averages for melons treated with ¾ and 1 pound whitewash per gallon water.

[4] Data for whitewashed melons are for whitewash with added thickener.

To obtain information on the incidence of SI in commercially harvested Crenshaws, we examined fruit in rows near our test plots. These melons included some that likely would be culled by the packing crew because of excessive SI. The incidence of SI was related to vine condition—the poorer the vines the higher the incidence of SI (table 3). Thus, in fields where the vines provide uniformly "very good" or better cover for the melons, whitewashing would not be advantageous. However, where vines provide only "good" or poorer cover, our results suggest that whitewashing would be useful.

Concentration of whitewash (¾ vs. 1 lb/gal water) did not influence the incidence or severity of SI, so the lower concentration appears to afford adequate protection.

The effectiveness of a whitewash is dependent

TABLE 3.—*Incidence of solar injury of Crenshaw melons harvested commercially, in relation to condition of vines at time of harvest, 1971–73*

Vine condition	Rows involved	Melons examined	Melons affected		Melons rated 7 or 9[1]	
			Range	Average	Range	Average
	No.	*No.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Very good	1	20	--	10	--	0
Good	5	205	10–42	27	5–21	11
Fair	3	86	45–65	56	26–35	29

[1] Severe or extreme (melon unmarketable).

on the degree of whiteness. The material with ½ percent thickener was whiter (fig. 8) and somewhat more effective in reducing pulp temperature (106° vs. 112° F at 1 to 2 mm depth) and SI than the material with less than 10 percent binder. The effectiveness of a highly reflective cover is further illustrated by the complete protection afforded Crenshaws that happened to be fully exposed to radiation for about 1 week prior to harvest (fig. 9); an injured area that existed on one of the melons prior to whitewashing, did not become enlarged during the prolonged exposure.

Regardless of formulation, thorough whitewashing of the upper portion of Crenshaws is essential if SI is to be minimized. Unless coverage is thorough, or vines are adequate, any exposed portion likely will be injured (fig. 10). Similarly, when the melons are sprayed and a leaf later dies and withers, an unprotected area may develop (fig. 11). However, because such areas usually are small, affected melons generally remain marketable.

Note that the borders of the SI and of the whitewash coincide (figs. 10 and 11) and that even small islands and projections of green surface (dark) remain where drops or streaks of whitewash had been deposited. Also note the sharp

PN–4221

FIGURE 9.—Crenshaw melons exposed 1 week to full radiation after whitewashing. Note good coverage and lack of solar injury on two of the melons, solar injury present at time of whitewashing (dark outline just perceptible in melon on left) did not enlarge.

FIGURE 8.—Rows of whitewashed Crenshaws: *Left*, material with less than 10-percent binder; *right*, material with ½-percent thickener added.

PN-4223 PN-4224

FIGURE 11.—Solar injury following death of leaf subsequent to whitewashing: *Left*, before whitewash removal; *right*, after whitewash removal. Note islands of normal (dark) surface in injured area. (From Lipton, *1971*.)

outline of normal tissue (whitewash removed near tip) that protrudes into the injured area (center of fig. 10). If temperature alone were responsible for SI, there should have been a diffuse border between normal and injured tissue, because a difference in surface temperature of 13° F between the white and dark surface would result in a temperature gradient, not a sharp transition. Thus, some form of radiation other than heat must have contributed to the injury. Ultraviolet radiation seems the most likely contributor.

Soluble Solids Content

Whitewashing had no adverse effect on the SSC of Crenshaws (table 4). There either was no significant difference between normal and whitewashed melons or the latter were slightly higher (in 1973) in SSC. Also, melons harvested 2 or 3 days after treatment did not differ in SSC from those harvested a week later. Melons whitewashed with 1 lb or three-quarters of a pound of material per gallon of water were about equal in SSC.

Decay

Fewer whitewashed melons were decayed after storage (10 days at 50° F plus 3 days at 68°) than nontreated melons (8 percent vs. 14 percent in 1971, 5 percent vs. 11 percent in 1973). However, because location of the decayed portions, mainly the stem end and ground spot, was not related to SI, the lower incidence of decay in whitewashed lots was due to chance or to some factor other than protection from radiation.

Removal of Whitewash

Reasonably complete whitewash removal after harvest is essential to provide an attractive, marketable melon. However, because the material is

TABLE 4.—*Soluble solids content (SSC) of shaded and whitewashed Crenshaw melons*

Year of test and part of melon sampled	SSC of melons [1]	
	Shaded by vines	White-washed
1971:	*Percent*	*Percent*
Top	10.4a	10.3a
Bottom	9.9a	9.6a
Average of entire melon	10.2a	10.0a
1972: [2]		
Top	10.2a	10.0a
Bottom	10.0a	9.6a
Average of entire melon	10.1a	9.8a
1973: [3]		
Top	8.9a	9.5 b
Bottom	8.6a	9.5 b
Average of entire melon	8.8a	9.5 b

[1] Percentages on a line followed by different letters differ at the 95-percent probability level.

[2] Data are averages for melons treated with ¾ and 1 lb whitewash per gallon water.

[3] Data for whitewashed melons are for whitewash with added thickener.

inert and nontoxic, whitewash removal is for appearance only.

The formulation that incorporates a thickener, used in 1973, permits virtually complete whitewash removal under field conditions. We used wet sponges to remove whitewash from samples of Crenshaws during all harvests in 1973, and during one harvest, the packing crew washed the melons on a mobile field packing unit (fig. 12). Washing required about 20±5 seconds for each melon. However, washing would be faster once established as routine, and it would even be simpler for melons washed in a stationary packing plant. Traces of whitewash that often remained on Crenshaws (fig. 13) were not considered objectionable by melon shippers.

PN-4225

FIGURE 12.—Removing whitewash by wet-sponging Crenshaw melons on a mobile field packing unit.

Cantaloups

Temperatures

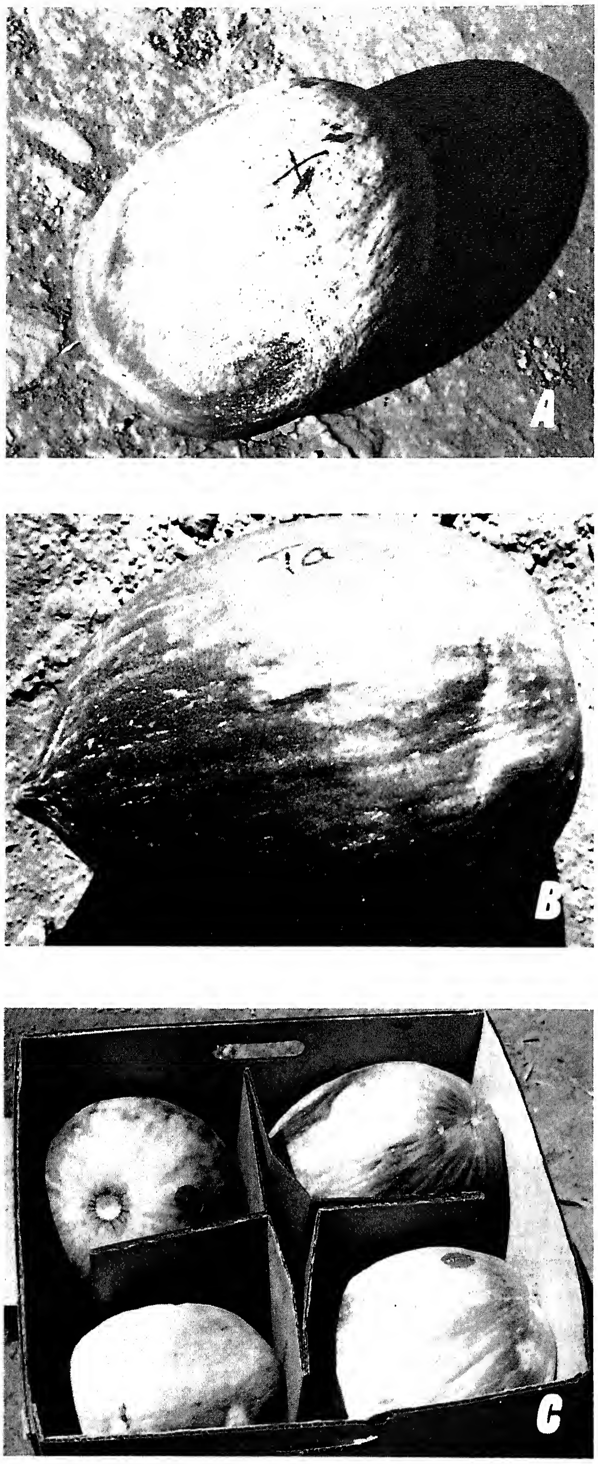
The maximum pulp temperature 1 to 2 mm below the surface was about 10° F lower in whitewashed than in untreated, exposed cantaloups, but whitewashing did not reduce temperatures as much as shading by the vines (fig. 14). Similar temperature differences occurred at the 15-mm depth. The temperature of exposed, whitewashed melons and normal melons exceeded the air temperature by 15° and 26°, respectively, whereas the temperature of shaded melons remained near the air temperature, when melons and air were at their respective maximums.

Surface temperatures (fig. 15) followed a pattern similar to the pulp temperatures. The maximum surface temperature of the whitewashed and normal melons differed by 8° F. The fluctuation in the surface temperature of the normal melon covered by vines is explained by its occasional exposure to direct radiation.

The surface of the normal, exposed melon heated to about the same extent as the underlying flesh (compare figs. 14 and 15); however, between about 10:30 a.m. and 1 p.m., the surface of the whitewashed melon was cooler than the flesh, just as it was in Crenshaws.

Solar Injury

In cantaloups, shippers are concerned only with severe or extreme SI, because lesser symptoms do not reduce the value of the fruit. Whitewashing virtually eliminated serious SI, even under conditions in which one-fifth of those not protected showed severe or extreme symptoms (table 5). Interestingly, the highest incidence of SI in normal melons occurred in July 1972, the period of lowest maximum temperatures for any of the tests (see table 1). This apparent contradiction is explained by the relatively poor condition of the vines (see table 1) in this test. Consequently,



PN-4226 PN-4227 PN-4228

FIGURE 13.—Crenshaw melons after removing whitewash with wet sponges: *A*, Melon before and, *B*, after wet-sponging; *C*, wet-sponged melons ready for shipment. Note that only traces of whitewash remain.

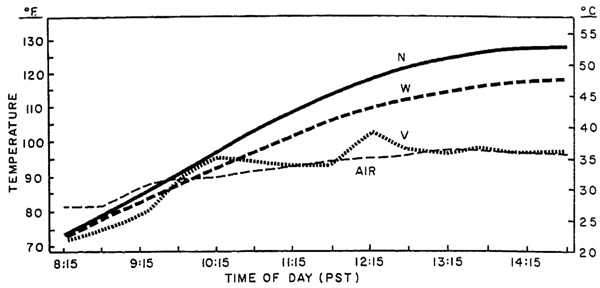


FIGURE 14.—Pulp temperatures of cantaloups 1 to 2 mm below South-West facing surface, near top, and air temperature in shade (July 16, 1971). N = normal melon exposed to sun; W = whitewashed melon exposed to sun; V = normal melon in shade of vines.

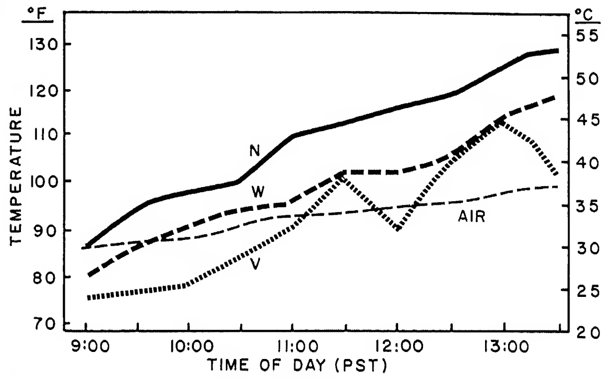


FIGURE 15.—Surface temperatures at top of normal (N), whitewashed (W), and vine-shaded (V) cantaloups, and temperature of air in shade (July 16, 1971).

in cantaloups, whitewash is an effective substitute for shading by the vines.

Neither concentration of whitewash nor presence of binder or thickener influenced the occurrence of SI of cantaloup.

Vein Tract Browning

Whitewashing had little effect on the occurrence of vein tract browning (vtb), a postharvest disorder. During the 3 years of the tests, severe and extreme vtb affected 17 percent of normal melons (range, 0 to 52 percent) and 12 percent of those whitewashed (range, 1 to 29 percent) when they were examined after storage for 8 days at 41° F plus 3 or 5 days at 68°. Slight vtb affected 49 percent of the melons (range, 17 to 88 percent) and moderate vtb affected 40 percent (range, 10 to 77 percent). The slight reduction in vtb due to

BLE 5.—*Influence of whitewashing on incidence of severe or extreme solar injury (SI) and on soluble solids content (SSC) of cantaloups* [1]

e of st	SI of melons with indicated treatment		SSC of melons with indicated treatment	
	Normal	White-washed	Normal	White-washed
	Percent	*Percent*	*Percent*	*Percent*
1:				
uly	5	0	--	--
.ugust	16	0	9.2	9.2
2: [2]				
uly	18a	4b	8.8a	9.1a
.ugust	3	0	8.8a	9.1a
3: [3]				
.ugust	13a	1b	--	--

For a given subject, percentages on a line followed different letters differ at the 95-percent probability el. Where whitewashed column is 0 percent or where ues are identical, no statistical analysis was used.
Data are averages for melons treated with ¾ and 1 whitewash per gallon water.
Data are averages for melons treated with whitewash h minimal binder and added thickener.

iitewashing was too inconsistent and too small be of practical significance.

luble Solids Content

Whitewashing had no substantial influence on ɜ SSC of cantaloups (table 5). Differences in SC due to whitewashing were minor, whether ɜ SSC was measured at harvest or after the ɜlons had been stored.

Decay

Incidence of decay after storage was recorded in 1971 and 1972, and it was negligible in both years, regardless of whitewash treatment.

Removal of Whitewash

The formulations of whitewash used in 1973 were removed by the commercial washer-brushers where the brushes contacted the melons near their equatorial bulge, but not completely toward the tapered ends where the brushes did not contact the melons as well (fig. 16). Before whitewashing of cantaloups can become a commercial practice, an improved method of removing the whitewash must be developed.

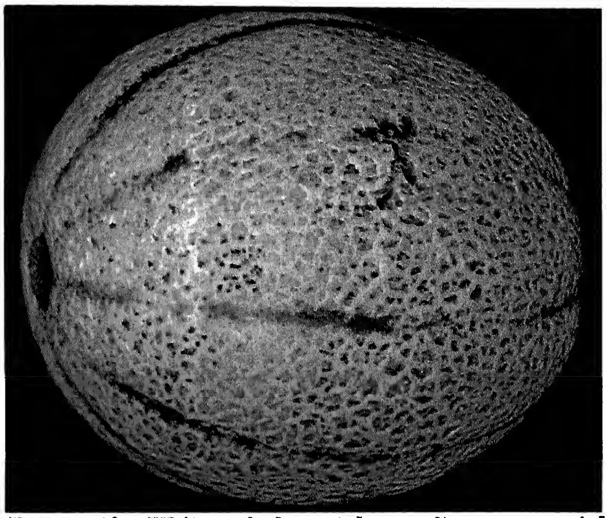


FIGURE 16.—Whitewashed cantaloup after commercial washing-brushing. Note incomplete removal of whitewash near tapered ends.

DISCUSSION

The incidence and extent of SI of Crenshaw d cantaloup melons causes substantial quantities these melons to be culled at the shipping point. ıch losses could be materially reduced for Crenaws and virtually eliminated for cantaloups, if ɘ maturing melons were protected from exces- re solar radiation by an inert, nontoxic whiteısh.

The whitewash can be applied with standard rayers, but certain precautions must be taken satisfactory results are to be achieved:

1. Melons must be whitewashed before a substantial number have been injured by exposure to direct sunlight due to inadequate coverage by vines. Whitewashing usually would be beneficial after the second or third harvest of Crenshaws and after the fourth or fifth harvest of cantaloups. Whitewashing provides little added benefit when vines adequately cover the melons. For harvests exceeding about 2 weeks, two applications of whitewash may be required, although this aspect was not specifically evaluated in our tests.

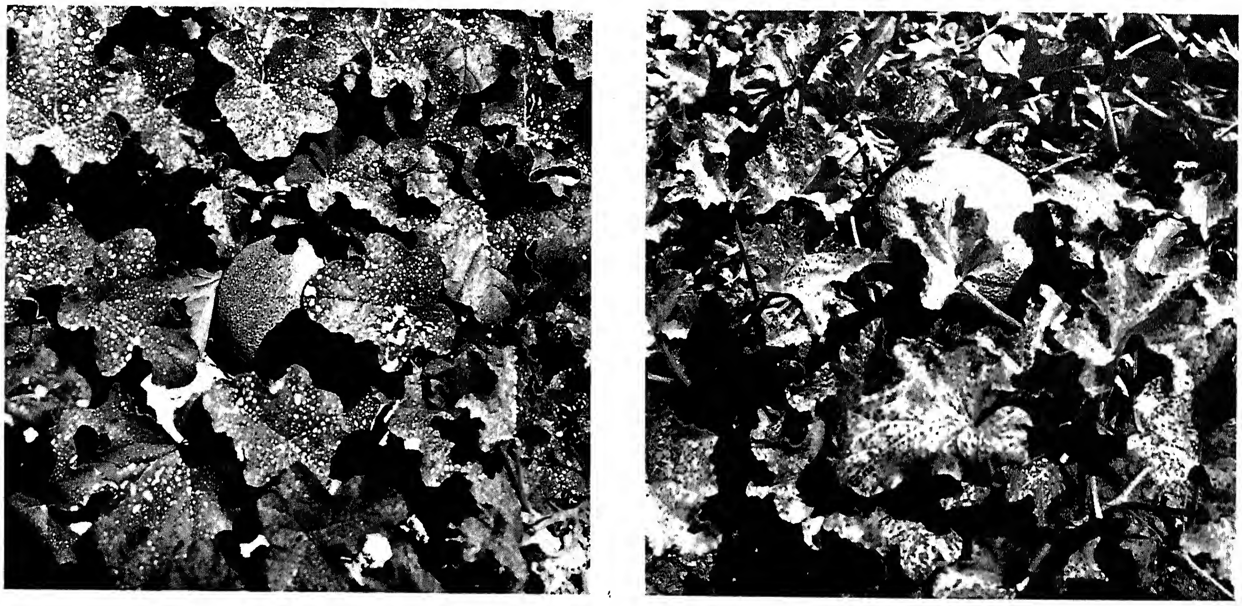
2. The whitewash must cover all exposed parts of the melon fruits as evenly as possible. In Crenshaws, due to their large size, care must be taken to angle the nozzles so that they spray from top and sides.

3. Proper coverage can be achieved only by use of a surfactant that facilitates a uniform cover of whitewash and thus prevents puddling (fig. 17). If puddling occurs, only those portions of melons covered by the material will be protected.

4. The whitewash must remain on the melons from time of treatment until harvest; however, it should not adhere so firmly that it is difficult to remove from the harvested melons. The proper balance between adhesion and ease of removal is the responsibility of the formulator and applicator, usually the same firm. No universally applicable recommendation on achieving this balance can be given, because of the characteristics of the particular whitewash material, the quality of the surface of the melons, and the climatic conditions that may affect the interaction between whitewash and melon surface.

5. Removal of the whitewash from Crenshaws is feasible whether they are packed in a shed or on a mobile unit in the field; however, availability of water is essential. If the melons are washed in a tub, the water should be changed and the tub cleaned at least once a day. Removal of the material from cantaloups likely could be improved by use of tumbler-type brushes rather than the straight-cut type now in use in packing plants.

Whitewashing has no adverse effect on soluble solids (sugar) accumulation in Crenshaws or cantaloups treated after the start of harvest. These results are reasonable in light of the finding that whitewashing not only did not reduce the rate of photosynthesis in walnut leaves, but increased it when only the upper surface was covered (*3*).



PN–4229 PN–4230

FIGURE 17.—Puddling of whitewash (left) and uniform coverage (right) on cantaloups.

CONCLUSIONS

Whitewashing melons, particularly Crenshaws, appears to be technically and economically feasible. With a yield of about 600 cartons of Crenshaws per acre, a 10-percent increase in marketable fruits, which seems to be readily attainable with whitewashing, would increase yields by 60 cartons per acre. At an average price of $2.50 per carton, additional gross returns of $150 per acre could be realized. The cost of whitewashing is about $12 per acre, increasing the net return

r about $138 per acre over that without white-ashing. Also, the amount now spent covering the elons would be saved, further adding to the net turn. However, the cost of removing the white-ash from the melons must be subtracted.

Similar calculations for cantaloups, assuming yield of 350 2/3-size cartons per acre, show a :t saving of about $106 per acre. With these elons, removal of the whitewash would entail) additional expense, because passing them over asher-brushers is a standard practice. The possibly higher cost of brushes that would assure removal of the material from the entire melon would be negligible on a per container basis.

Whitewashing also would eliminate the stoop labor required to manually cover Crenshaws with vines. Finally, the reduction in the incidence of severe SI, particularly of Crenshaws, would lead to a more attractive product, with greater consumer acceptance and sales, especially if some of the net savings were passed on to the consumer.

LITERATURE CITED

1) California Crop and Livestock Reporting Service.
1973. CALIFORNIA VEGETABLE CROPS ACREAGE PRODUCTION AND VALUE 1964–1972. County acreage 1971–1972, 33 pp.

2) Daniels, G. E.
1968. MEASUREMENT OF GAS TEMPERATURE AND THE RADIATION COMPENSATING THERMOCOUPLE. Jour. Appl. Met. 7: 1026–1035.

3) Foot, J. H., and Heinicke, D. R.
1967. WHITEWASH FOUND HARMLESS IN APPLICATIONS ON WALNUT LEAVES. Calif. Agr. 21(3): 2–3.

4) Jackson, R. D., and Idso, S. B.
1969. AMBIENT TEMPERATURE EFFECTS IN INFRARED THERMOMETRY. Agron. Jour. 61: 324–325.

5) Lipton, W. J.
1970. EFFECTS OF HIGH HUMIDITY AND SOLAR RADIATION ON TEMPERATURE AND COLOR OF TOMATO FRUITS. Amer. Soc. Hort. Sci. Jour. 95: 680–684.

(6) ———
1971. WHITEWASHING CRANSHAWS (SIC) TO REDUCE SUNBURN. West. Grower and Shipper 42(11): 79–80.

(7) ——— and Matoba, F.
1971. WHITEWASHING TO PREVENT SUNBURN OF 'CRENSHAW' MELONS. HortScience 6: 343–345.

(8) Ryall, A. L., and Lipton, W. J.
1972. HANDLING, TRANSPORTATION, AND STORAGE OF FRUITS AND VEGETABLES. V. 1. VEGETABLES AND MELONS. AVI Publishing Co., Westport, Conn. 473 pp.

(9) Serr, E. G., and Foott, J. M.
1963. EFFECT OF WHITEWASH COVER SPRAYS ON PERSIAN WALNUTS IN CALIFORNIA. Amer. Soc. Hort. Sci. Proc. 82: 243–249.

(10) Snedecor, G. E., and Cochran, W. G.
1967. STATISTICAL METHODS. Ed. 6. Iowa State University Press, Ames. 593 pp.

(11) United States Department of Commerce.
CLIMATOLOGICAL DATA (FOR DATES GIVEN). Natl. Oceanographic Atmos. Admin., Environmental Data Serv.

Trade names and the names of commercial companies are used in this publication solely to provide specific information. Mention of a trade name or manufacturer does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture nor an endorsement by the Department over other products not mentioned.

USDA policy does not permit discrimination because of race, color, national origin, sex, or religion. Any person who believes he or she has been discriminated against in any USDA-related activity should write immediately to the Secretary of Agriculture, Washington, D.C. 20250.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1975 O—589-885